Uczenie maszynowe i sztuczna inteligencja w finansach
Prognoza cen samochodów

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89575	album2	album3

28 stycznia 2024

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Spis treści

1 Biblioteki i dane

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[1]:
```
import pandas as pd
import geopandas as gpd
from matplotlib import pyplot as plt
```

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[2]:
```
df = pd.read_csv("otomoto.csv")
df = df.drop(columns=["OPIS", "OSTATNIA_AKTUALIZACJA"])
```

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[3]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 151360 entries, 0 to 151359
Data columns (total 9 columns):
 #   Column                Non-Null Count   Dtype
---  ------                --------------   -----
 0   TYTUŁ                 151360 non-null  object
 1   ROK_PRODUKCJI         133434 non-null  float64
 2   PRZEBIEG_KM           133428 non-null  float64
 3   POJEMNOŚĆ_SILNIKA_CM3 151147 non-null  float64
 4   PALIWO                151360 non-null  object
 5   MIASTO                151360 non-null  object
 6   WOJEWODZTWO           151360 non-null  object
 7   CENA                  151360 non-null  int64
 8   WALUTA                151360 non-null  object
dtypes: float64(3), int64(1), object(5)
memory usage: 10.4+ MB
```

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[4]:
```
df = df[df.WALUTA != 'EUR']
```

2 Exploratory data analysis

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2.1 Dane numeryczne

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[5]:
```
df.describe().astype(int)
```

[5]:

	ROK_PRODUKCJI	PRZEBIEG_KM	POJEMNOŚĆ_SILNIKA_CM3	CENA
count	133414	133408	151128	151340
mean	2012	163790	1937	58185
std	6	92676	836	65134
min	1937	1	480	1250
25%	2009	94296	1469	17900
50%	2012	179010	1798	35900
75%	2017	224000	1997	74999
max	2023	1943000	7990	1966770

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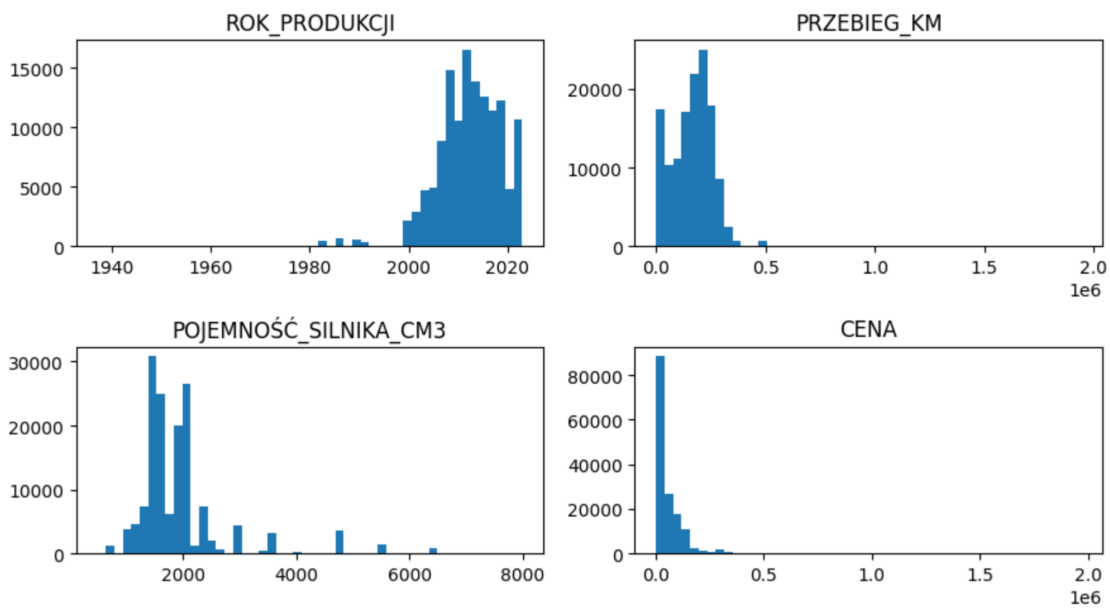
[6]:

```
fig, ax = plt.subplots(2, 2, figsize=(9, 5))
for i, stat in enumerate(("ROK_PRODUKCJI", "PRZEBIEG_KM",␣
↪"POJEMNOŚĆ_SILNIKA_CM3", "CENA")):
    div, mod = divmod(i, 2)
    ax[div, mod].hist(df[stat], bins=50)
    ax[div, mod].set_title(stat)
plt.tight_layout()
plt.show()
```



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[7]:

```
df.corr(numeric_only=True)
```

[7]:

```
                    ROK_PRODUKCJI  PRZEBIEG_KM  POJEMNOŚĆ_SILNIKA_CM3 ␣
↪\
```

```
ROK_PRODUKCJI              1.000000    -0.640512               -0.017783
PRZEBIEG_KM               -0.640512     1.000000                0.087809
POJEMNOŚĆ_SILNIKA_CM3     -0.017783     0.087809                1.000000
CENA                       0.609888    -0.641578                0.220893

                           CENA
ROK_PRODUKCJI          0.609888
PRZEBIEG_KM           -0.641578
POJEMNOŚĆ_SILNIKA_CM3  0.220893
CENA                   1.000000
```

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2.2 Dane kategoryczne

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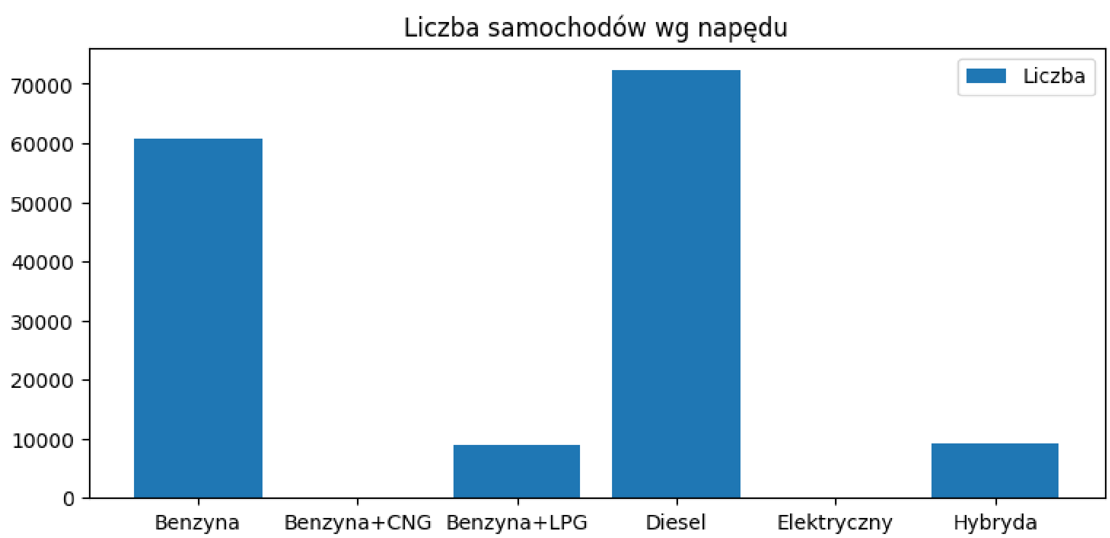
[8]:
```
naped = df.groupby("PALIWO")[["CENA"]].count()
plt.figure(figsize=(9, 4))
plt.bar(naped.index, naped.CENA)
plt.legend(["Liczba"])
plt.title("Liczba samochodów wg napędu")
plt.show()
```



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[9]:
```
woj_data = (
    df.groupby("WOJEWODZTWO")
    .CENA.describe()
```

```
    .round(2)
    .sort_values("count", ascending=False)

)
woj_data[["count", "mean", "std"]]
```

[9]:

WOJEWODZTWO	count	mean	std
Mazowieckie	26650.0	83636.14	68158.56
Wielkopolskie	25600.0	44594.14	58038.32
Dolnośląskie	19225.0	43793.56	41021.80
Małopolskie	16082.0	42221.08	48355.71
Świętokrzyskie	11331.0	71837.12	30127.82
Śląskie	11193.0	79787.73	108573.26
Lubuskie	7625.0	42991.48	24576.86
Lubelskie	6852.0	46321.08	36391.10
Zachodniopomorskie	5937.0	40753.79	36539.75
Pomorskie	5711.0	36369.68	64280.16
Kujawsko-pomorskie	4163.0	106685.15	126183.36
Opolskie	3721.0	18415.88	28880.51
Podkarpackie	3635.0	41783.20	31857.93
Łódzkie	2468.0	127234.22	81833.37
Podlaskie	825.0	136824.31	80407.67
Warmińsko-mazurskie	320.0	65661.71	69956.99
Belgia	2.0	30749.00	1060.66

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[10]:
```
woj_shp = gpd.read_file("wojewodztwa.zip")[["JPT_NAZWA_", "geometry"]]
woj_shp.JPT_NAZWA_ = woj_shp.JPT_NAZWA_.str.capitalize()
```

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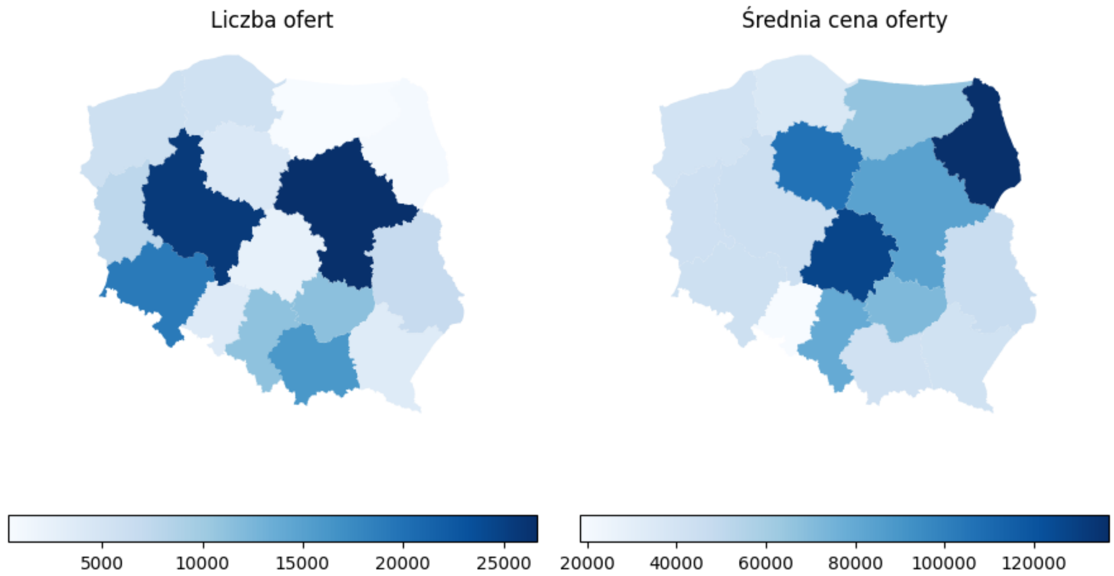
[11]:
```
woj_plot = woj_shp.merge(
        woj_data, how="outer", left_on="JPT_NAZWA_",␣
 ↪right_on="WOJEWODZTWO"
    ).dropna().set_index("JPT_NAZWA_")
```

[12]:
```
fig, ax = plt.subplots(1, 2, figsize=(9, 5))
ax1 = woj_plot.plot("count", ax=ax[0], legend=True, cmap="Blues",␣
 ↪legend_kwds={"orientation": "horizontal"})
ax1.set_axis_off()
ax1.set_title("Liczba ofert")
ax2 = woj_plot.plot("mean", ax=ax[1], legend=True, cmap="Blues",␣
 ↪legend_kwds={"orientation": "horizontal"})
ax2.set_axis_off()
ax2.set_title("Średnia cena oferty")
```

```
plt.tight_layout()
plt.show()
```



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[13]:
```
df.loc[0, 'TYTUŁ']
```

[13]: 'Skoda Superb 2.0 Comfort'

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[14]:
```
df.insert(1, 'MARKA', df.TYTUŁ.str.split(' ').str[0])
```

[15]:
```
marki = df.groupby("MARKA").CENA.describe().round(2).sort_values("count",␣
  ↪ascending=False)
marki[['count', 'mean', 'std']].head(10)
```

[15]:

MARKA	count	mean	std
Ford	16232.0	38581.29	25463.85
Volkswagen	14343.0	33141.09	33817.38
Opel	11316.0	19765.17	15144.27
Toyota	9312.0	28684.19	25234.61
BMW	9179.0	99011.68	109428.93
Jeep	8589.0	150863.91	23737.61
Audi	8234.0	115730.76	104048.98
Skoda	6935.0	37460.26	35298.70
Mercedes-Benz	6459.0	104704.07	98882.41

```
Renault          6456.0    44929.53    27769.33
```

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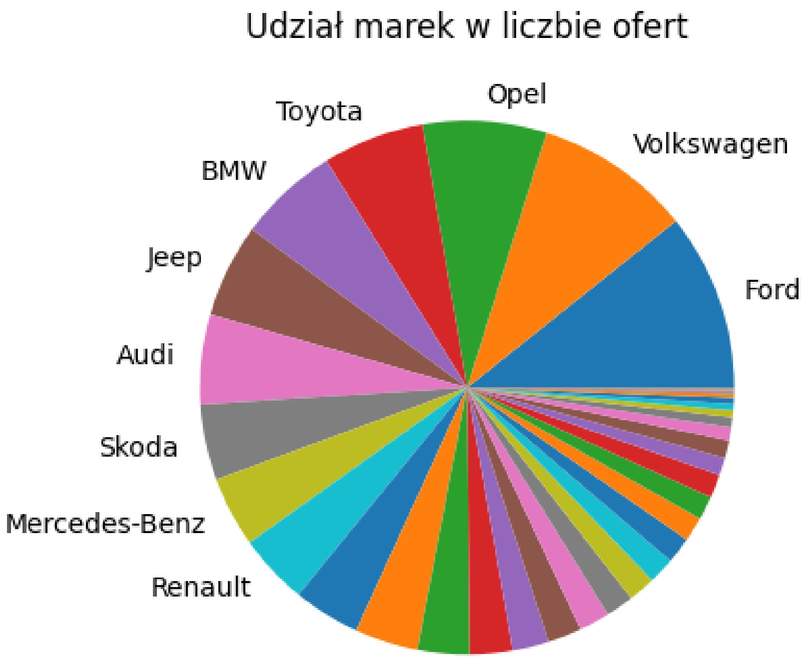
[16]:
```python
labels = [label if i < 10 else "" for i, label in enumerate(marki.index)]
plt.figure(figsize=(6,4))
plt.pie(marki['count'], labels=labels)
plt.title('Udział marek w liczbie ofert')
plt.tight_layout()
plt.show()
```



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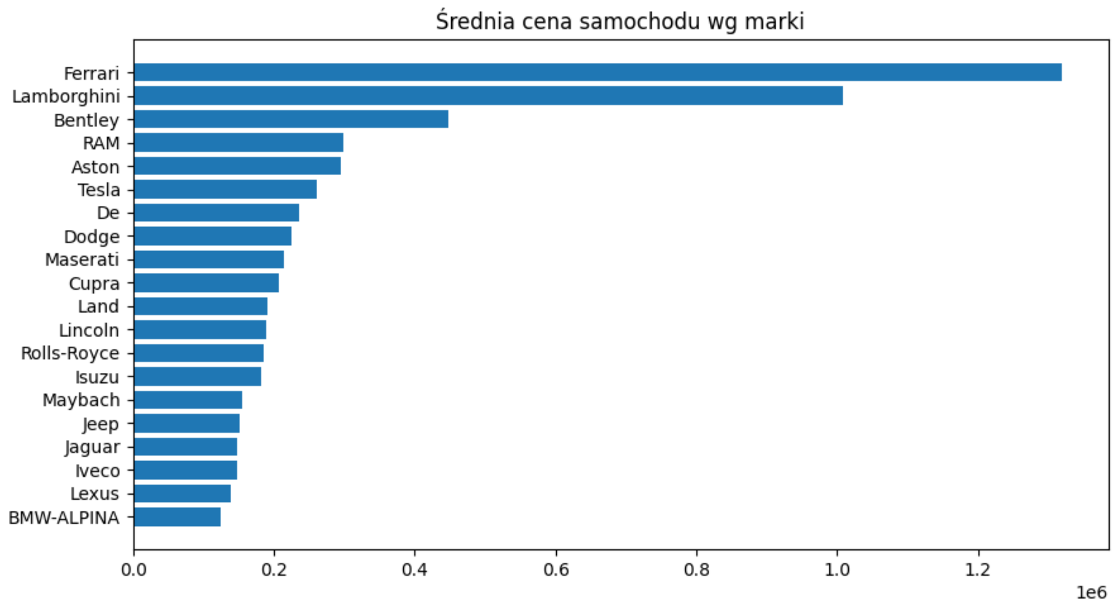
[17]:
```python
marki = marki.sort_values("mean").tail(20)
plt.figure(figsize=(9, 5))
plt.barh(marki.index, marki["mean"])
plt.title("Średnia cena samochodu wg marki")
plt.tight_layout()
plt.show()
```



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3 Model

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3.1 Budowa transformatora i predyktora

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[18]:
```
from sklearn.preprocessing import StandardScaler, OneHotEncoder
from sklearn.compose import ColumnTransformer
from sklearn.impute import SimpleImputer
from sklearn.pipeline import Pipeline
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score, mean_absolute_error
from sklearn import set_config
set_config(display="text")
```

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[19]:
```
num_cols = ["ROK_PRODUKCJI", "PRZEBIEG_KM", "POJEMNOŚĆ_SILNIKA_CM3"]
cat_cols = ["MARKA", "PALIWO","WOJEWODZTWO"]
```

pipeline

[20]:
```
preprocessor = ColumnTransformer([
    ("numerical", Pipeline([
            ("imputer", SimpleImputer(strategy="median")),
            ("scaler", StandardScaler())]
        ), num_cols),
    ("categorical", OneHotEncoder(handle_unknown="ignore"), cat_cols),
])
default_model = Pipeline([("preprocessor", preprocessor), ("regressor",␣
↪LinearRegression())])
```

3.2 Przygotowanie i trening

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[21]:
```
from sklearn.model_selection import train_test_split
```

[22]:
```
df = df.drop(columns=['TYTUŁ', 'MIASTO', 'WALUTA'])
y = df.CENA
x = df.drop(columns=['CENA'])
```

dla zobrazowania małe sety danych

[23]:
```
x_train, x_test, y_train, y_test = train_test_split(x, y, train_size=0.
↪05, test_size=0.01, random_state=42)
```

[24]:
```
default_model.fit(X=x_train, y=y_train)
pass
```

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[25]:
```
from sklearn.metrics import mean_absolute_error, r2_score
```

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[26]:
```
y_pred = default_model.predict(X=x_train)
```

[27]:
```
mae = mean_absolute_error(y_train, y_pred)
r2 = r2_score(y_train, y_pred)
mae, r2
```

[27]:
```
(19256.167848500572, 0.744092478959515)
```

notatka

3.3 Przeszukiwanie siatki

[28]:
```python
from sklearn.linear_model import LogisticRegression, LinearRegression
from sklearn.svm import SVR
from sklearn.neighbors import KNeighborsRegressor
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor
```

notatka

[29]:
```python
from sklearn.model_selection import GridSearchCV
```

notatka

[30]:
```python
param_grid = [
    {"regressor": [LinearRegression()]},
    {"regressor": [LogisticRegression(random_state=42)]},
    {"regressor": [KNeighborsRegressor()]},
    {"regressor": [SVR()]},
    {"regressor": [DecisionTreeRegressor(random_state=42)]},
    {"regressor": [RandomForestRegressor(random_state=42)]},
]
```

[31]:
```python
gscv_model = GridSearchCV(estimator=default_model, param_grid=param_grid,␣
 ↪n_jobs=-1)
```

[32]:
```python
gscv_model.fit(X=x_train, y=y_train)
pass
```

[33]:
```python
pd.DataFrame(gscv_model.cv_results_).set_index("rank_test_score").
 ↪sort_index()[
    ["param_regressor", "mean_test_score"]
]
```

[33]:

rank_test_score	param_regressor	mean_test_score
1	RandomForestRegressor(random_state=42)	0.938634
2	DecisionTreeRegressor(random_state=42)	0.909744
3	KNeighborsRegressor()	0.905837
4	LogisticRegression(random_state=42)	0.873001
5	LinearRegression()	0.731528
6	SVR()	-0.121414

znaleziono lepszy randomforestregressor

[34]:
```python
y_pred = gscv_model.predict(x_train)
```

[35]:
```
mae = mean_absolute_error(y_train, y_pred)
r2 = r2_score(y_train, y_pred)
mae, r2
```

[35]: (976.0301943302412, 0.9912686902554559)

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3.4 Klasyfikator głosujący

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[36]:
```
from sklearn.ensemble import VotingRegressor
```

notatka

[37]:
```
regr = VotingRegressor(
    estimators=[
        ("forest", RandomForestRegressor(random_state=42)),
        ("knn", KNeighborsRegressor()),
        ("tree", DecisionTreeRegressor(random_state=42)),
    ],
)
voting_model = Pipeline([("preprocessor", preprocessor), ("regressor",␣
↪regr)])
```

notatka

[38]:
```
voting_model.fit(x_train, y_train)
pass
```

[39]:
```
y_pred = voting_model.predict(x_train)
```

[40]:
```
mae = mean_absolute_error(y_train, y_pred)
r2 = r2_score(y_train, y_pred)
mae, r2
```

[40]: (1196.9951266742087, 0.9878689266331786)

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3.5 Fine Tuning

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[41]:
```
param_grid = {
    # 'regressor__forest__n_estimators': [50, 100, 200],
    'regressor__forest__max_depth': [None, 5],
    # 'regressor__knn__n_neighbors': [2, 5, 10],
```

```
    # 'regressor__tree__max_depth': [5, 25, 50],
    # 'regressor__tree__min_samples_split': [2, 10, 20]
}
```

[42]:
```
voting_gscv = GridSearchCV(estimator=voting_model, param_grid=param_grid,␣
↪n_jobs=-1)
```

notatka

[43]:
```
voting_gscv.fit(x_train, y_train)
pass
```

notatka

[44]:
```
voting_gscv.best_params_
```

[44]:
```
{'regressor__forest__max_depth': None}
```

notatka

[45]:
```
y_pred = voting_gscv.predict(x_train)
```

[46]:
```
mae = mean_absolute_error(y_train, y_pred)
r2 = r2_score(y_train, y_pred)
mae, r2
```

[46]:
```
(1196.9951266742087, 0.9878689266331786)
```

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4 Podsumowanie

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[ ]:
```

```

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5 Bibliografia

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dane: OTOMOTO.pl

wpisy do bibliotek:
- matplotlib - pandas - geopandas - sklearn - numpy